Structural Equation Modelling of Public Construction Procurement Systems Implementation in Nigeria

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Various procurement methods have been deployed by government organisations to deliver vital infrastructure to support socio-economic development in different spheres of life in Nigeria. However, there is a lack of empirical understanding relating to the contribution of public procurement process, barriers, drivers and selection criteria combined to project delivery in Nigeria context. This study identified five major constructs which were conceptualised to establish how different procurement options influence project delivery. The constructs were operationalized and developed into a questionnaire in a cross-sectional study. Data were sought from professionals involved in the management, design and operations of construction projects in Lagos and Abuja (i.e. project managers, architects, engineers, quantity surveyors, and procurement officers). The data were analysed using Partial Least Square Structural Equation Modelling (PLS-SEM) in order to determine the link among the constructs interrogated. The findings indicated that all the latent variables included in the conceptual model jointly contributed 59 per cent of variance explained. It was also revealed that drivers of procurement selection and selection criteria are significantly related to effective project delivery. Findings from this research show that for project to be successful in terms of cost, time, and other characteristics as stated in this paper, the most critical approaches to adopt are design-and-build and collaborative procurement. This implies that making the correct choice of construction procurement strategies is a recipe for project success. Government authorities and business organizations seeking infrastructure and procurement system improvements at various levels could use the developed model to improve project delivery.

Keywords: Procurement systems, Public procurement process, Infrastructure, Structural Equation Modelling, Public agencies

INTRODUCTION

Governments in any country throughout the world are the largest clients of the construction industry and, as such, are regarded as the most important procurers of works, products and services, or public goods to civil society (Dlungwana *et al*., 2002, Oyewobi, 2014). Procurement is part of a broader set of government actions aimed at increasing efficiency and inventiveness in the way services are organized, provided, and distributed in order to improve customers' livelihoods and user experience. This is underscored by Manu *et al*. (2021), who stated that public procurement processes is being employed by government to deliver vital infrastructure to support socio-economic development at different scales. In Nigeria, the procurement strategy is one of the primary tools for achieving development objectives such as poverty reduction and the provision of healthcare, infrastructure, education, and other services, and on the long run, contributes to the optimum use of government resources.

However, Nigeria has a long history of problems with public procurement system. According to a World Bank Country Assessment conducted in 2000, procurement fraud accounted for 60% of all government spending. The corruption in the allocation of contracts has been reported to cost Nigeria $10 billion a year in lost revenue between 1999 and 2000 (Country Procurement Assessment Report, 2000). In 2015, the Bureau of Public Procurement (BPP) announced that the Public Procurement Act of 2007 has saved the country N659 billion from contracts awards between 2009 and 2014 (Ezeh, 2015). The savings were estimated as the difference between the contract prices initially submitted to the Bureau for approval and the final contract pricing after the Bureau conducted a downward revision. Despite this assertion, Nigeria's ratings on the Corruption Perception Index remained poor, indicating that the country's public procurement process is in disarray. This is affirmed by the Independent Corrupt Practices and other related offences Commission sixteen years after the World Bank report, by arguing that 60% of corruption cases in Nigeria involved procurement (Vanguard, 2016).

However, this is not only limited to Nigeria, Organisation for Economic Co-operation and Development (OECD, 2016) stated that among the many government functions across the globe, public procurement is especially prone to graft. This is largely due to the intricacy of the process, the close relationship between public officials and enterprises, and the large number of interested parties which together increase the likelihood of corruption (OECD, 2016). This underlined the OECD Foreign Bribery Report (2014), which found that nearly two-thirds of foreign bribery instances analysed were in industries directly related with contracts or licensing through public procurement,

indicating that public procurement is susceptible to corruption.

Therefore, the Nigerian government believes that comprehensive public procurement regulations and practices are key ingredients for good governance. This means that excellent procedures are thought to be cost-effective while still producing the intended goals, whereas bad practices frequently result in waste and delays, as well as serving as a springboard for claims of corruption and government inefficiencies. Corruption and inefficiency can have a negative impact on good governance, so the Nigerian government decided to implement a public procurement system to minimise the inadequacies as quickly as possible (Oyewobi *et al*., 2017). According to Attah (2009), procurement accounts for about 80% of Nigerian government expenditures at all levels, this reflects the International Trade Centre, ([ITC], 2014) assumption that procurement in some developing countries, may account for as much as 70%. This is also consistent with Neupane (2014), who stated that procurement in the public sector accounts for 15% of a country's gross domestic product (GDP).

As a consequence, it is necessary to strengthen the agencies that conduct public procurement in order to lessen this threat and establish a procurement process that is transparent in aiding the public sector in achieving its goals. Over time, however, a plethora of distinct categories of procurement methods have emerged in the construction sector (Oyegoke *et al*., 2009). In a related development, Love *et al*. (2012) posited that government clients have used various procurement approaches to transfer risk and liability among supply chain participants in actualizing infrastructure projects. Among these procurement approaches are the traditional, design-and-build (D&B), and Public Private Partnership (PPP) models. Traditional procurement methods are the most popular among these, and despite widespread criticism, public agencies remain steadfast in their commitment to them (Love *et al*., 2008).

Uyyara *et al*. (2014) noted that despite various motivating factors that greeted their deployments, numerous barriers impede the public sector from reaping the full benefit of the process, though Chan (2007) suggested that the selection and use of an adequate procurement system implementation is a crucial determinant for the success of an infrastructure project. In the light of this, clients have continued to face the issue of poor project delivery, which necessitated further research on the empirical relationship between procurement system implementation and outcomes in order to engender a more effective strategy for the delivery of infrastructure projects (Laryea, 2019). Although quite a number of studies have attempted to investigate different aspects of procurement such as selection process (Alhazmi & McCaffer, 2000; Chan, 2007; Love *et al*., 2012), influence of choice of procurement on the project performance (Eriksson & Westerberg, 2011; Hampton *et al*., 2012), and estimate the transaction costs (TCs) for different procurement systems (Rajeh *et al*., 2015); however, there is a dearth of study that focus on modelling public procurement processes that could lead to successful project delivery in Nigeria context using a second generation multivariate method of analysis.

This study contended that if a relevant public procurement process follows the fundamental principles, it will eliminate the barriers that may limit the selection process for a suitable procurement approach, and then effective project delivery will be close to being achieved. The development of a conceptual model that describes the relationship between the public procurement process, the drivers and barriers to the implementation of various procurement systems, as well as the selection criteria that could lead to successful project delivery, is the primary objective of this study. As a result, the purpose of this study is to investigate these aspects in relation to the three distinct procurement systems that are utilized in construction projects (the traditional system, the design-build system, and the PPP system), with the intention of comparing how well each system performs in terms of project delivery.

LITERATURE REVIEW AND CONCEPTUAL FRAMEWORK

Literature Review

The construction procurement process is crucial to the client's and project's success because it establishes the parameters within which roles and duties will be carried out throughout the construction phase. The proliferation of different procurement strategies, the growing technical complexity of infrastructure projects, and the persistent requirement for rapid project start-up and finish times have all contributed to a better contract administration and the attendant selection procedure for procurement system implementation.

It has been established that the selection of a relevant procurement option is capable of reducing costs of public sector infrastructure projects by 5% (Gordon, 1994; Alhazmi & McCaffer, 2000). Although no two projects are entirely the same, but individual project has specific requirements and peculiar characteristics needed to be successful, thus procurement technique is employed to solve the technical puzzles of infrastructure project together with the client and contractor requirements (Alhazmi & McCaffer, 2000). There has been proliferation of procurement methods in the construction in past few years, and this has called for careful selection of the procurement method that will meet specific client objectives and needs in an effective

way (Masterman, 2002). However, in Nigeria, the favoured procurement method is the traditional procurement method which has been greatly criticised for being serial in nature, due to the inherent separation in the design and construction process that often lead to adversarial relationship amongst stakeholders or most times disputes (Cheung &Yiu, 2006). In spite of the heavy criticism of traditional procurement methods, public sector organisations across the globe firmly stick to the approach in the delivery of infrastructure projects (Love *et al*., 2008).

There is no "one-size-fits-all" procurement solution in the construction industry because different projects require different procurement strategies (Love *et al*., 1998). In spite of the claims of Rwelamila and Meyer (1999) and Luu *et al*. (2005), an effective procurement procedure does not automatically guarantee a successful project. As previously stated by Bowen *et al*. (1999), the abysmal performance of the construction industry can be attributed to the wrong selection of the procurement system. Given the variety of procurement methods and the factors that must be examined, stakeholders face a monumental challenge when tasked with selecting the best procurement method for public infrastructure projects (Love *et al*., 2008; Oyegoke *et al*., 2009). However, as argued by Ofori (2006), developing nations need to adopt procurement systems that are tailored to their specific cultural norms and commercial practices. Noor (2011) found that the poor performance of construction projects in developing nations is mostly attributable to a lack of attention to and incorporation of cultural factors into the procurement procedures of these projects.

Although there is agreement that some procurement approaches are superior to others, it is generally agreed that no single approach is optimal in all cases (Love *et al*., 1998). However, some decision-makers may have concern in determining the suitability of different procurement procedures, even though it has been shown that doing so can increase the likelihood of a project's success (Rwelamila & Meyer 1999; Luu *et al*., 2005). This is due to the fact that decision makers cannot rely on their own past project experiences to adequately account for the wide variety of procurement options, client traits and wants, project features, and external factors that may impact a given endeavour (Kumaraswamy & Dissanayaka, 2001).

Conceptual Framework

The study considered economic organizational theories such as agency theory and transaction cost economics (TCE) in examining how individuals and organizations relate to one another in the context of exchanges of commodities and services (transaction cost analysis) and contracts (agreements for specific transactions) (agency analysis). Therefore, a conceptual framework model was developed on the basis of these theoretical expectations and previous empirical studies by incorporating the latent variables with their corresponding measures (Rajeh *et al*., 2015). The study models the direct and indirect relationships between latent variables, i.e. public procurement process, drivers and barriers to different procurement systems implementation, and project delivery. In this study, it is assumed that these constructs (as shown in Figure 1) collectively determine how successful the delivery of infrastructure projects could be.

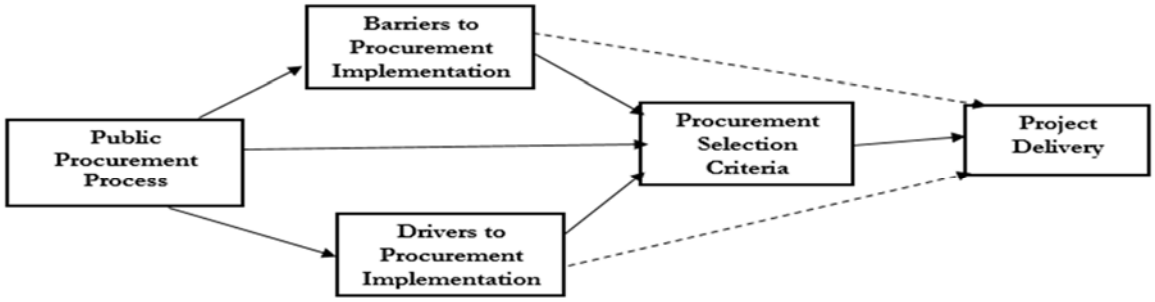

Figure 1: Conceptual framework

Public Procurement Process

Thai (2009) stated that there are four main components that make up the public procurement system: procurement policies, rules and regulations, procurement professionals, procurement processes and methodologies, and procurement management. In recent times, public procurement has been increasingly employed as a policy instrument in a variety of disciplines, such as industrial policy, unemployment reduction, improved working conditions, and regional economic development (Gidigah *et al*., 2022). It is legitimate to use public procurement to accomplish

particular policy aims, and doing so is essential to delivering value to the public (Grandia & Meehan, 2017). It is widely agreed that the public procurement process is a crucial means through which these policies can be put into effect (Arrowsmith, 2010). In Nigeria the hallmark of public procurement process includes but not limited to the following: economy; efficiency; fairness; reliability; transparency; accountability and ethical standards (Bureau of Public Procurement [BPP], 2011). This is because accountability is a necessity for procurement credibility and a crucial enticement to individual and institutional probity. As a result, public procurement systems must emphasise ethical practices, organizational capability, procurement process management, and transparent contractor selection; a sound procurement system integrates all of the aforementioned features to drive the process and reduce barriers to its successful implementation. It is thus hypothesised that:

H1. Public procurement process is positively related to the drivers of procurement selection
H2. Public procurement process is positively related to the barriers of procurement selection
H3. Public procurement process is positively related to the procurement selection criteria

Barriers and Drivers to Implementation of Procurement Methods

According to Oyegoke *et al*. (2009), numerous procurement strategies have emerged to help decision-makers select the most appropriate approach to implementing a procurement solution from among the many feasible options. However, the decision-making process has become more difficult due to the fact that the nature of the obstacles or points of dispute must be taken into account when choosing a procurement technique (Naoum & Egbu, 2016). While Oyegoke *et al*. (2009) acknowledged the difficulty of the construction project process, they emphasised the importance of the many parties involved in the intricate contractual relationships that are an integral part of it. Despite this, Love *et al*. (2008) claimed that while each type of procurement approach has its advantages, most of them are overly prescriptive and overlook the selection process' intrinsic complexity. While these techniques of procurement have seen widespread use, they have also encountered a number of challenges (Leiringer, 2003; Love *et al*., 2008; Hampton *et al*., 2012). Lam *et al*. (2006) found that high levels of risk and responsibility can act as a barrier on D&B implementation. Yang *et al*. (2010) noted that different barriers have slowed down implementation and diminished private sector interest in PPPs. The slowness of traditional procurement methods, the fact that design and construction are kept separate, and the failure to take advantage of cost-cutting opportunities were all cited as reasons for their rejection (Hampton *et al*., 2012). Though these obstacles are tremendous in scale, governments in various countries continue to justify their implementation. Transparency concerns (Love et al., 2008), inefficiencies in both traditional and alternative procurement methods (Jin & Doloi, 2007), and a dearth of necessary skills and experience in the public sector (Gidado, 2010) are just a few of the factors driving organizations to experiment with new approaches to procurement. This study therefore stated and proposed that the elimination of the barriers and engendering the drivers of effective project delivery could be achieved via the selection of relevant criteria.

H4: Drivers of procurement selection is positively and indirectly related to the selection criteria for effective project delivery
H5: Barriers of procurement selection is positively and indirectly related to the selection criteria for effective project delivery
H6: Drivers of procurement selection is positively and indirectly related to measures of effective project delivery
H7: Barriers of procurement selection is positively and indirectly related to the measures of effective project delivery

Selection Criteria

According to Chan (2007), the selection and usage of an adequate procurement system is a critical aspect in the success of an infrastructure project. However, according to Eyitope *et al*. (2012), identifying the most effective procurement strategy appears to be an ambiguous and onerous undertaking, leading to project failure and increased risk, particularly in Nigeria. However, a wide variety of interested stakeholders with varying perspectives and requirements must weigh in on the final decision, and their perspectives and needs must be taken into account if an effective method for procuring public infrastructure projects is to be found (Love *et al*., 2008). Nonetheless, there is little consensus on how to properly select a procurement strategy that can guarantee efficient delivery infrastructure without encountering delay or overruns, despite the substantial apparent expertise of players in the public sector (Love *et al*., 2012). Ratnasabapathy *et al*. (2006) and Abdul Rashid *et al*. (2006), for example, found a significant positive association between the procurement strategies studied and the time and cost performance of construction projects, which is consistent with the findings of prior research such as Chan *et al.* (2001). Ghadamsi and Braimah (2014) established that selection criteria have strong relationships with one or more project performance outcomes. As they are, the existing procurement selection techniques are difficult to adapt

to the dynamic needs of public sector clients. In the light of this, it becomes clear that there is a pressing need to model procurement selection criteria for public infrastructure projects in order to employ more systematic approaches to choosing an appropriate procurement system implementation for a given construction project, given the increase of divergent procurement methods. Hence the study postulated that:
H8: Procurement selection criteria is positively related to the measures of effective project delivery

RESEARCH METHODS

The objective of the cross-sectional study was met by the adoption of a quantitative approach using questionnaire survey design. As a result of this, a model for the relationship between the public procurement process, the drivers and barriers to the implementation of various procurement systems, the selection criteria, and the measures of project delivery, has been developed. A well-structured questionnaire was developed after the model was operationalized and administered amongst construction professionals. Information was collected for the study from those with a stake in public sector infrastructure projects in Abuja and Lagos, Nigeria. The selection of these two areas was predicated on a number of criteria, including: the presence of procurement law (Abuja: Procurement Act 2007; Lagos State: Public Finance Management law 2011) in the study area that set the rules and policies for procuring construction projects; the ease with which a survey could be conducted to obtain the necessary data; the availability of practitioners in management, design, and operations; and the concentration of a larger percentage of construction professionals. Authorities in the public sector (such as government ministries, departments, and agencies), as well as contractors, make up the target demographic. A total of 1504 individuals represent the sampling frame for this study and to ensure that the results are representative of the population as a whole, Kadam and Bhalerao (2010) recommend using a large enough sample size. This study adhered to this recommendation by adopting a non-response bias approach, calculating the minimum sample size (Glenn, 2013), and therefore, a total of 411 questionnaires were distributed, 216 were returned, with Abuja (FCT) accounting for 63% and Lagos accounting for the remaining 37%. According to Akintoye (2000), a response rate of between 20% and 30% is considered adequate for findings in most social science studies. As a result, the 52.6% response rate obtained for this study is deemed adequate.

There were two parts in the survey. In the first part of the questionnaire, the paper discussed the demographics of the respondents, including the types of organizations represented, the respondents' educational backgrounds, and the lengths of their professional careers. A five-point Likert scale was used to design the questions, with five representing the highest possible score. The reliability and validity of the instrument were evaluated to guarantee reliability of results and effectiveness in the constructs used. Nanjundeswaraswamy (2021) recommended using a coefficient value of larger than 0.6 when conducting an internal reliability test to determine whether or not to use an instrument. All the constructs used in this analysis have a Cronbach alpha of more than 0.6. These values suggest that the study's questionnaire scales are internally consistent and reliable, as tested by a reliability test of the entire scale. The validity of the study was examined by assessing how well the results match theoretical constructs and other indicators of the same concept. Accordingly, the results demonstrated that the instrument employed was valid and reliable (Wong, 2013). Descriptive statistics were used to examine respondents' demographic information, and Partial Least Square Structural Equation Modelling was used to examine the the proposed model.

Data Analysis

The study used SmartPLS 3.0, software designed in accordance with the PLS methodology, to conduct the statistical analysis (Ringle *et al*., 2005). In the area of partial least squares structural equation modeling (PLS-SEM), this software is considered to be among the top choices (Sarstedt *et al*., 2014). This approach is highly accepted in the areas of hypothesis testing and validation, as well as the confirmation of the existence of significant links (Jiatong *et al*., 2022). Through the use of PLS-SEM, theoretical concepts may be transformed into latent variables (which can then be measured) and operational concepts can be transformed into metrics, all of which can be linked by a theory or hypothesis (Ringle *et al*., 2014). To evaluate PLS-SEM, one must first perform a preliminary model evaluation, then establish the validity of the measurement model, and then evaluate the structural model (Jiatong *et al*., 2022). The data were also examined for common method bias before PLS-SEM was used. This was done using Harman's single-factor test. When a single latent variable accounts for most of the explained variance, Podsakoff *et al*. (2003) warned, common method variance becomes problematic. According to the recommendation of Podsakoff *et al*. (2003), the study utilized un-rotated exploratory factor analysis to investigate for such a bias. Harman's single-factor test showed that the factor analysis contains many factors. And the first non-rotated element does not account for more than half the inter-indicator variability. Therefore, bias due to the use of a specific methodology is not an issue.

RESULTS AND DISCUSSION

Table 1 reveals the background information of the respondents, their academic qualifications and years of experience in the industry. The result presented in Table I shows the general information of the respondents. From the table, it is clear that all the construction professionals such as architects, quantity surveyors, civil, electrical, and mechanical engineers were well represented in this study. For instance, more responses were gotten from architects (28.24%), followed by quantity surveyors (25.93%), builders (20.83%), engineers (20.83%), and others (such as Project manager) (0.5%). In terms of academic qualifications, the table revealed that more than half (50.9%) of the respondents had a bachelor's degree, and this was followed by a master's degree (34.7%) and a diploma (6%) while the least qualified were a doctorate degree and others (OND, HND) with 4.2% and 4.2%, respectively. This was likely expected as the study is strictly focused on professionals of the construction industry. In terms of years of working experience in the construction industry, Table 1 shows that 17.1% of the respondents have above 25 years of working experience in construction industry, while 70.8% of respondents had from 25-5 years and below. Only 12% of respondents had less than 5 years. This is an indication that most of the respondents could be deemed to have adequate knowledge of the study due to their years of working experience in the construction industry.

Table 1: General Information of Respondents

Item	Frequency	Valid Percent	Cumulative Percent
Profession			
Architect	61	28.24	28.2
Quantity Surveyor	56	25.93	54.17
Builder	53	24.54	78.7
Engineer	45	20.83	99.5
Others	1	0.46	100
Highest academic qualification			
Diploma	13	6	6
Bachelor degree	110	50.9	56.9
Master degree	75	34.7	91.7
PhD	9	4.2	95.8
Others	9	4.2	100
Years working in construction industry			
Less than 5 years	26	12	12
5-10 years	37	17.1	29.2
11-15 years	62	28.7	57.9
16-20 years	40	18.5	76.4
21-25 years	14	6.5	82.9
Above 25 years	37	17.1	100

Assessment of the Measurement Model

In order to evaluate the reflective outer models, the internal consistency, indicators reliability, composite reliability (CR), convergent validity, and discriminant validity of a reflective measurement model were examined (Hair *et al*., 2014; Hair *et al*., 2017) as shown in Table 2. The internal consistency for the model was assessed using Cronbach's alpha and the values range between 0.695 and 0.827 for the five (5) assessed constructs. The Cronbach alpha values for all the measures were greater than 0.60, the threshold for acceptability in exploratory studies of this kind (Wong, 2013). The indicator's reliability value can be calculated by squaring each of the outer loadings. An ideal value would be 0.70 or higher. However, it is permissible to have a value of 0.4 or higher if the study is exploratory in nature (Hulland, 1999). Composite reliability (CR) depicts the degree to which items indicate the constructs. Table 2 show that all the CR values exceeded the suggested value of 0.7 (Hair *et al*., 2013) and convergent validity which involves the degree to which individual items reflect a construct converging in comparison to items measuring different constructs. Convergent validity was assessed using the value of average

variance extracted (AVE). Convergent validity is considered acceptable when the AVE value of a construct is ≥ 0.5 (Hair *et al*., 2017). Table 2 shows that all the AVE values exceeded the suggested value of 0.5. Items in the constructs were differentiated from one another using discriminant validity, which also measures the degree of dissimilarity between overlapping constructs (Hair *et al*., 2014). Discriminant validity is different from convergent validity because it examines whether or not the items accidentally measure something other than the intended construct. Three different criteria (item cross loading, Fornell- Larcker's criterion and the Heterotrait-Monotrait (HTMT) ratio) can be used in PLS-SEM to evaluate discriminant validity (Henseler *et al*., 2016; Hair *et al*., 2019). To evaluate item cross loading, the paper calculated the correlation between item scores on different constructs. If the factor loadings for each construct are greater than those for any other constructs, it depicts that the items belonging to the various constructs are distinct. Each specified construct has a higher factor loading than any other construct, as shown in Table 3. According to Fornell- Larcker's criterion, a construct should have the highest degree of similarity to its assigned items relative to any other construct. In this approach, the AVE square root is compared to the correlation between variables. A construct should explain the variance of its own indicator rather than the variance of other constructs. Therefore, as can be seen in Table 3, the AVE of each construct was greater than its correlations with all other constructs when the AVE was squared (Hair *et al*., 2014).

The estimation of the genuine correlation between two constructs is demonstrated by the heterotrait-monotrait (HTMT) ratio strategy. It is preferable to aim for an HTMT value of 0.90 or less. When the value is greater than 0.90, discriminant validity is lacking (Henseler et al., 2015; Franke & Sarstedt, 2019). All the assessed constructs in Table 4 have a ratio of 0.90 or lesser, indicating that they all meet the criterion. Both the Fornell-Larcker criterion and the HTMT showed satisfactory levels of discriminant validity and measurement model quality in this research. All the indicators reliability for this study were above 0.7 minimum threshold. The evaluation of multicollinearity found that the variance inflation factor (VIF) of majority of the variables was below the benchmark of 5.0, which is considered to indicate good collinearity.

Table 2: Results of reflective measurement model

Latent Variables	Indicators	Indicator Coding	Factor loadings	Cronbach's Alpha	rho_A	Composite Reliability	AVE	VIF
Barriers hindering the selection of procurement	Design and build	BBD	0.829	0.742	0.757	0.849	0.653	1.620
	Collaborative (P.P.P)	BPPP	0.797					1.770
	Traditional design bid build system	BTP	0.797					1.313
Drivers influencing procurement selection	Design and build	DDB	0.852	0.827	0.828	0.897	0.743	1.915
	Collaborative (P.P.P)	DPPP	0.887					2.148
	Traditional design bid build system	DTP	0.846					1.726
Public Procurement Process	Ethical isues	Ethics	0.778					1.767
	Organisational capability	Org_Cap	0.743	0.802	0.826	0.868	0.622	1.625
	Procurement Process Management	Proc_Process	0.804					1.464
Procurement selection criteria	Contractor Selection	Contractor_Sel	0.828	0.695	0.698	0.831	0.622	1.750
	Selection Criteria 1	Sel_Crt1	0.746					1.270
	Selection Criteria 2	Sel_Crt2	0.792					1.390
	Selection Criteria 3	Sel_Crt3	0.82					1.468
Project Delivery	Cost	Cost	0.747	0.807	0.813	0.873	0.633	1.537
	Quality	Quality	0.834					1.805
	Client Satisfaction	Client Satisfaction	0.805					1.685
	Time	Time	0.796					1.600

Table 3: Discriminant validity –Fornell-Larcker criterion

Latent Variable	Barriers hindering the selection of procurement	Drivers influencing procurement selection	Project Delivery	Public Procurement Process	Procurement selection criteria
Barriers hindering the selection of procurement	**0.808**				
Drivers influencing procurement selection	0.272	**0.862**			
Project Delivery	0.257	0.742	**0.796**		
Public Procurement Process	0.329	0.475	0.502	**0.789**	
Procurement selection criteria	0.253	0.72	0.663	0.355	**0.789**

The off-diagonal values in the above matrix are the correlations between the latent constructs and diagonal are square values of AVEs

Assessment of the Structural Model

In this section, the results of both the direct and indirect relationships that exist between the constructs that make up the model are presented. However, according to Hair et al. (2017), structural model validation in PLS-SEM involved a procedure consisting of five steps: assessing the structural model for collinearity issues, assessing the relevance and significance of structural relationships expressed in the model, assessing the coefficient of determination (R^2), assessing the effects size (f^2), and assessing the predictive relevance Q^2 for the model. The issue of collinearity was investigated in this study to determine whether or not the indicators are highly correlated to one another. This was done as a rule of thumb. According to the results of the test in Table 2, the VIF values are lower than 5, so there are no collinearity problems with the indicators (Hair *et al*., 2014).

The next step is to evaluate the model's structural relationships for their significance and relevance. Both the path coefficients and the statistical significance of a relationship between two constructs can be checked through an examination of the connection between them. In order to have an effect within the model and be statistically significant at the 0.05 level, the path coefficients need to be greater than 0.100 (Assaker *et al*., 2012). Except for three of the eight hypothesized relationships (public procurement process and selection criteria (β=0.001), barriers to procurement methods selection and selection criteria (β=0.061), and barriers and project delivery (β=0.044)), all other path coefficients are greater than the 0.100 threshold (see Figures II & III). The coefficient of determination (R^2) is a measure of the model's explanatory power, and it is a representation of the variance explained in each endogenous construct (Shmueli & Koppius, 2011). Across many fields of study in the social sciences, R^2 values of 0.75, 0.50, and 0.25 are typically regarded as substantial, moderate, and weak, respectively (Hair, Ringle, & Sarstedt, 2011). The study's structural model was found to have an R^2 of 0.587, indicating that the combined constructs accounted for approximately 59% of the variance in effective project delivery as shown in Figure II and Table 4. This is considered acceptable in the context of this research. This is supported by Raithel *et al*. (2012) who argued that the minimum acceptable R^2 value depends on the research context, and that in some fields, an R^2 value of 0.10 is considered satisfactory.

The significance of each of the hypothesized relationships is an essential part of evaluating the model. When extrapolating from a small sample to a larger population, researchers should check the significance of the path coefficient (β), as pointed out by Henseler *et al*. (2019). This was accomplished using bootstrapping with a 5000- resamples size, as recommended by Henseler *et al*. (2016). In this particular instance, the t-value from the bootstrap is used to determine the significance of the path coefficients. In accordance with the conventional confidence interval, a t-value of 1.65 was considered to indicate a 90% confidence level ($p<0.10$), a t-value of 1.96 was chosen to indicate a 95% confidence level ($p<0.05$), and a t-value of 2.58 was chosen to indicate a 99% confidence level ($p<0.01$) (Wu *et al*., 2019). Table 6 displays the results, including the t-value and the hypothesised relationship.

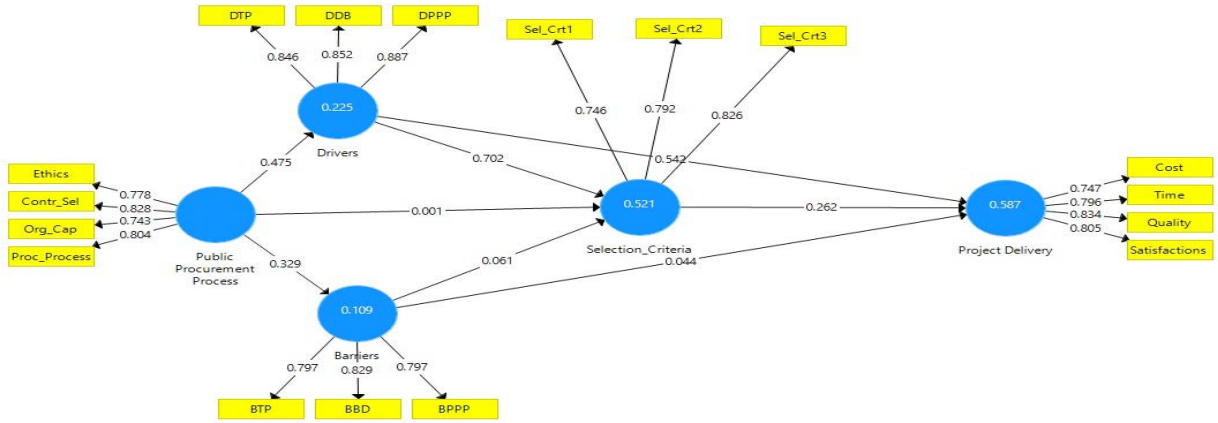

Figure II: PLS algorithm results showing path coefficients with loadings and R^2

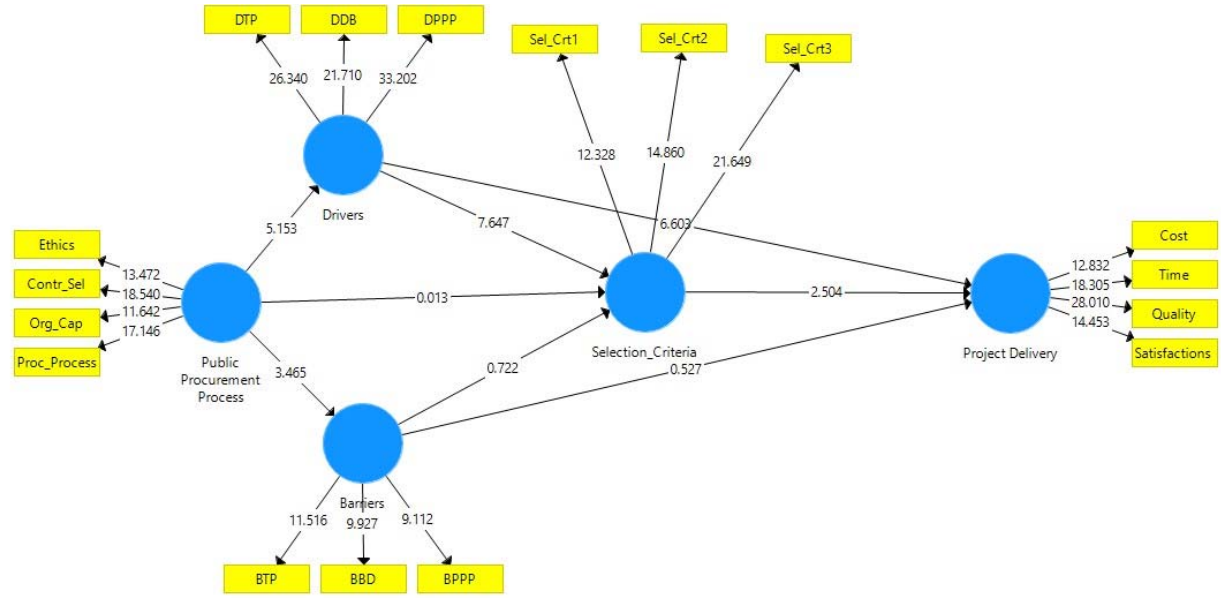

Figure III: Bootstrapping Results showing path significance (T-statistics)

The f^2 effect size, which is analogous to the size of the path coefficient, is also used to determine how the elimination of a particular predictor construct impacts the R^2 value of an endogenous construct. Table 5 demonstrates that the f^2 values are not all zero; rather, they span a wide range from relatively small to relatively large, thus surpassing the threshold of zero (Henseler *et al*., 2009). An additional test for model fitness, Q^2 is a criterion for judging the accuracy with which the model estimates the missing information. Chin (2010) proposes that a model has predictive relevance when Q^2 is greater than 0 as shown in the results presented in Table 4. Using the partial least square (PLS) blindfolding procedure, it was determined that the value of Q^2 for successful project completion was 0.385, which is positive. Therefore, the model had a good fit and good predictive relevance. Analysis showed that the standardised root mean squared residual (SRMR) value was 0.090, the chi-squared value was 289.850, and the normed fit index (NFI) value was 0.661. This finding indicates that the model's SRMR and NFI do not fall outside the thresholds specified for the investigation. In order to get a better idea of how well the model fits the data, the goodness of fit (GoF) index was computed; the result was 0.54, which is above the threshold set by Akter *et al*. (2011), who stated that a GoF value of 0.36 is considered large.

Table 4: Heterotrait-Monotrait ratio and Psychometric properties of the structural model

Latent Variable	Barriers hindering the selection of procurement	Drivers influencing procurement selection	Project Delivery	Public Procurement Process	R2	Q2
Barriers hindering the selection of procurement					0.109	0.291
Drivers influencing procurement selection	0.319				0.225	0.464
Project Delivery	0.320	0.600			0.587	0.385
Public Procurement Process	0.404	0.564	0.615			0.369
Procurement selection criteria	0.379	0.65	0.686	0.431	0.521	0.251

Table 5: Effect size (f2)

	f2	Effect Size
Barriers -> Project Delivery	0.004	Small
Barriers -> Selection Criteria	0.007	Small
Drivers -> Project Delivery	0.337	Large
Drivers -> Selection Criteria	0.783	Large
Public Procurement Process -> Barriers	0.122	Medium
Public Procurement Process -> Drivers	0.291	Medium
Selection Criteria -> Project Delivery	0.079	Small

Table 6: The Summary of hypotheses tested (Total effects)

Hypothetical Paths	Mean Statistics	T-statistics	P-Value	Remark
Barriers -> Project Delivery	0.06	0.710	0.478	Not Supported
Barriers -> Selection Criteria	0.061	0.722	0.470	Not Supported
Drivers -> Project Delivery	0.726	13.110	0.000	Supported
Drivers -> Selection Criteria	0.702	7.647	0.000	Supported
Public Procurement Process -> Barriers	0.329	3.465	0.001	Supported
Public Procurement Process -> Drivers	0.475	5.153	0.000	Supported
Public Procurement Process -> Project Delivery	0.365	4.294	0.000	Supported
Public Procurement Process -> Selection Criteria	0.355	3.303	0.001	Supported
Selection Criteria -> Project Delivery	0.262	2.504	0.012	Supported

Discussion of Findings and Testing of Hypotheses

The study used PLS-SEM to analyse the hypothetical paths included in the conceptual model developed to improve public procurement process with the aim of improving the effectiveness of project delivery. Coefficient sizes and t-statistic values for all hypothetical paths indicated that some of the latent exogenous variables were substantial predictors of successful project delivery. PLS-SEM results showed the significance of all modelled paths, demonstrating that all modelled latent variables contributed to the variance explained by the model (R^2 values). An analysis of the structural loadings on project delivery found that the largest loading factor associated with indicators of successful project delivery is the drivers of public procurement selection. This supported the assertion of Polonsky *et al*. (2022) who demonstrated that understanding barriers and drivers for the public sector is therefore critical, for enhancing the selection procurement of goods and services.

Table 6 shows that, of the eight hypothesized relationships among the constructs and the outcome of the project's delivery, five were significant. Testing H1 (public procurement process is positively associated to the drivers of procurement selection) yielded a positive and significant result (r=0.475, t=5.153, p=0.000). The findings demonstrated the significance of the public procurement process and drivers in ensuring the timely and successful completion of projects. This supports the claim of Paulraj *et al*. (2006) that the effectiveness of procurement processes is a critical aspect in determining the effectiveness of an organization, as inefficient procurement procedures not only reduce profit margins but also affect the success of the business as a whole.

Worthy of note is that, a positive and statistically significant correlation was discovered between the public procurement procedure and its impediments (r=0.329, t=3.465, p=0.001). The results, however, lend credence to the second hypothesis (H2), which posited a positive correlation between the public procurement process and the barriers to procurement choice. This correlation could be attributed to the fact that, in the public sector procurement process, it is crucial to have an understanding of the barriers and drivers that exist in order to effectively utilize the drivers and overcome the barriers that exist in the process (Polonsky *et al*., 2022). Additionally, Hypothesis 3 was investigated, and the data indicated that there was a positive association between selection criteria and the public procurement process; however, this relationship is not significant. In the light of this, it may be deduced that the selection criteria and the procurement procedure do not have a direct and meaningful link with one another. Despite the fact that Buzzetto *et al*. (2020) suggested that choosing a supplier is one of the most important things to do throughout the procurement process, this is not always the case. On the other hand, if there is no acceptable and accurate technique to choose the best possible contractor, the overall performance of the project can suffer as a result (Cheng & Li, 2004).

According to the findings of this study, the strongest positive connection can be seen between the drivers and the selection criteria (r = 0.702, t = 7.647, p = 0.000). This substantiates the claim made in hypothesis (H4), that the selection criteria for good project delivery are positively related to the drivers of procurement selection. This is in line with the findings of Bhutto *et al*. (2019), who stated that procurement selection drivers can help the client choose the best procurement options among the many methods of procurement. The study examined hypothesis 5 which assessed whether barriers to procurement selection is positively related to the selection criteria. The result revealed that there is positive but insignificant relationship between the constructs. This finding is consistent with empirical research findings reported by Shiyamini *et al*. (2007) who acknowledged that inconsistency in the effective decision making process due to the influence of individuals and other external factors can have the potential to influence project success.

The objective of the study is to examine the validity of hypothesis 6, which asserts that measures of successful project delivery are positively correlated with the drivers of procurement choice. The results supported this hypothesis by showing a positive correlation between the drivers of procurement selection and project delivery (r=0.542, t=6.603, p=0.000). Shiyamini *et al*. (2007) reached the same conclusion, arguing that it is important to consider the drivers of procurement selections to guarantee project success and satisfy client needs. When comparing design-bid-build with the design-build method, Idiake *et al*. (2015) found that the latter was less effective in terms of cost, time, and quality of finished construction projects. There was no significant relationship found between the predicted project delivery factors and the barriers to selecting a procurement method (p=0.598, t=0.527, =0.044).These results provided some support for the seventh hypothesis (H7), which stated that barriers to procurement selection are positively associated to the metrics of effective project delivery. According to Babatunde (2015), the capacity to recognize the barriers that could prevent a project from being successful through procurement would allow the stakeholders participating in the process to develop strategies to overcome the barriers.

In order to verify the validity of Hypothesis 8, which proposes that the procurement selection criteria have a positive correlation with the delivery of the project, the hypothesis was analysed, and the findings of the analysis pointed to the proposition (r= 0.262, t=2.504, p=0.012), indicating the existence of a significant relationship between the two variables. According to Shiyamini *et al*. (2007), having good selection criteria is necessary to ensure that the client receives value for the money that is invested on the project. In a similar vein, Bhutto *et al*. (2019) noted that selecting the procurement technique to be used for the awarding of public sector projects is a difficult procedure that has a direct impact on the delivery of the project. Therefore, making the incorrect choice of construction procurement strategies almost always results in the failure of the project or overall dissatisfaction on the part of the client.

CONCLUSION

This study used PLS-SEM to evaluate the conceptual model that was presented in the paper. It modelled the relationship between the public procurement process, the drivers and barriers to the implementation of various procurement systems, as well as the selection criteria that could lead to successful project delivery. In spite of the growing efforts of academics on the topic, particularly in the context of Nigeria, approximately

sixty percent of unethical behaviours in the sector are procurement-based. Studies on procurement have assumed many dimensions and have garnered a lot of attentions. Previous research has focused almost exclusively on developed nations and the question of how the process of procurement selection could improve the performance of projects. The purpose of the study was to build and validate a conceptual model that described a number of hidden variables that were hypothesized to have an effect on the efficient delivery of a project. The findings of the analysis conducted using PLS-SEM provided support for the conceptual model as well as all of the hypotheses that were offered. According to the findings, all of the latent constructs have an impact on project delivery, albeit to varying degrees. The conceptual model that was developed in this study could provide a foundation for future research that determines how selection criteria could act as a mediator between the drivers of procurement method selection. Barriers could moderate drivers, process and selection criteria in project delivery. Additionally, the conceptual model could act as a mediator in the relationship between public procurement process and project delivery or performance.

The findings of this study have significant implications for practice since the study interrogated how procurement process management influences the delivery of projects. Several of the findings of the study have managerial implications because they demonstrated that there was a significant relationship between the procurement process and the procurement systems selection drivers and criteria. This significant relationship has the potential to have a positive impact on the delivery of the project. The findings could provide policymakers at diverse levels and types of public institutions with the information they need to make strategic decisions that will ensure the appropriate procurement methods are chosen for the appropriate projects in order to achieve the procurement goals that have been established. This study also gives public entities who are involved in the acquisition of infrastructure with justifiable cause for investing in the establishment of a transparent procurement procedure, which will minimize unethical practices to the barest minimum possible. These findings provided an important argument for the necessity of continuing efforts in improving the ability of such organizations to ensure and promote the continuous accomplishment of procurement objectives.

Despite the fact that the findings of this study provided some helpful insights, it was noted that there were key limitations. The research methodology adopted had certain limitations that were inherent. The study utilised a quantitative survey to collect responses from procurement personnel and experts from a range of public and private organisations. These individuals were assumed to have an acceptable understanding of the topic. As a result, it was not possible to delve any farther into the fundamental explanations concerning the impacts of the latent constructs that were included in the model. In the light of this, additional research could be carried out by adopting making use of qualitative methods in order to discover additional empirical facts.

In addition to this, the study identified the primary trends as well as gaps in the existing literature. It seems that social procurement is becoming an increasingly popular issue for discussions on procurement management. There are not enough studies that concentrate on the linking that exists between the selection criteria, the procurement procedure, and the different dimensions of project delivery. These are some areas that can be investigated further in subsequent studies. Evidence from the currently available literature also demonstrated that the majority of the research being conducted on this subject is qualitative, with some studies being conducted through case-based research; thus, more confirmative findings are required. Specifically, it would be beneficial to conduct future research by adhering to the research variables and relationships that were investigated in this study.

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